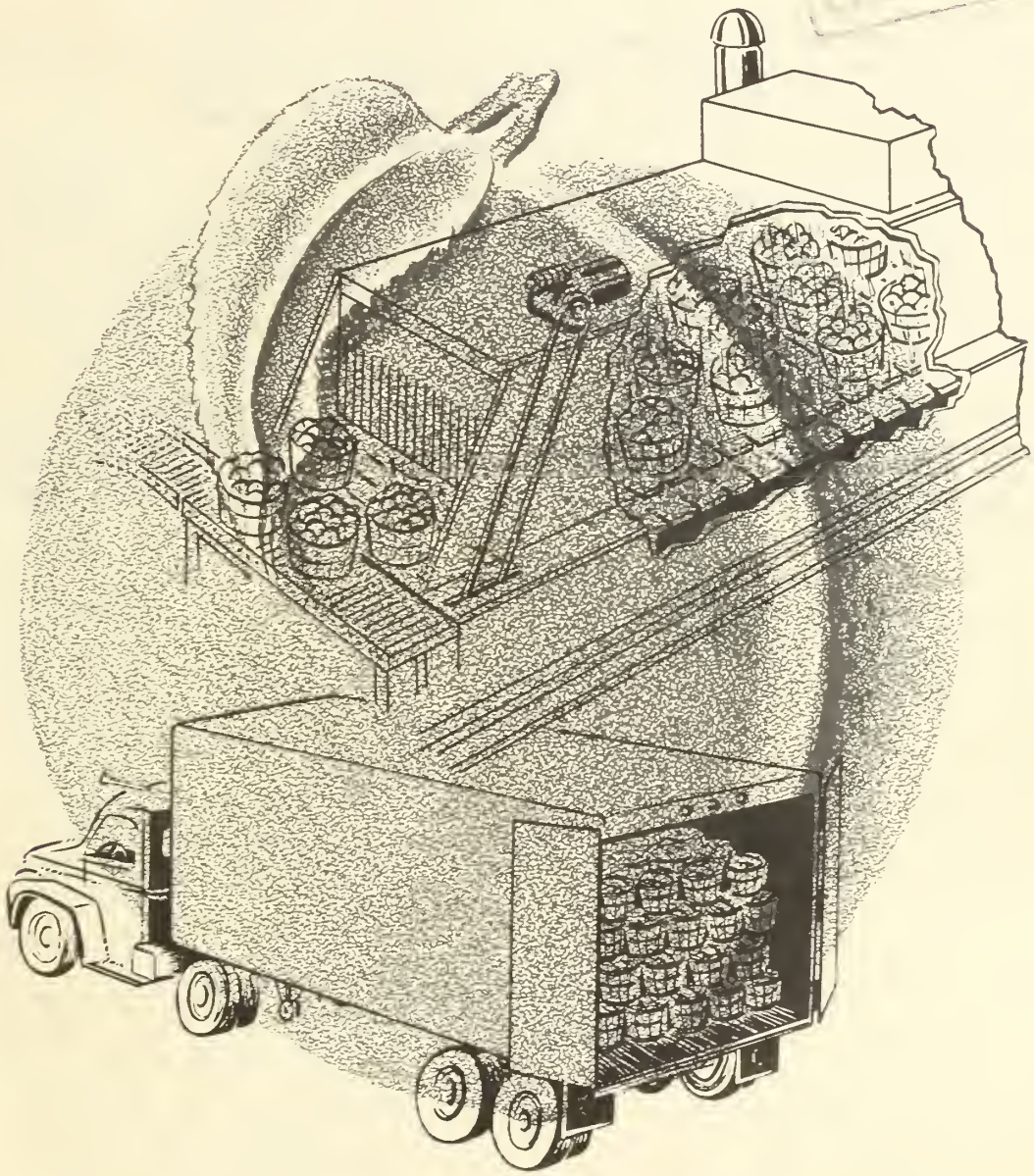
PEACH HYDROCOOLING, SHIPPING, AND FUNGICIDAL TESTS

Part I. Test of Pennsylvania Peaches, 1955
Part II. Test of South Carolina Peaches, 1956



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PEACH HYDROCOOLING, SHIPPING, AND FUNGICIDAL TESTS

Part I. Tests of Pennsylvania Peaches, 1955

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Part II. Tests of South Carolina Peaches, 1956

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PEACH HYDROCOOLING, SHIPPING, AND FUNGICIDAL TESTS

BACKGROUND OF STUDY

During recent years considerable interest has developed in southeastern and eastern areas in harvesting and shipping more mature peaches. In order to delay ripening and hence decrease bruising, rapid lowering of the temperature of such fruit is essential. Flood-type hydrocooling has been adopted in some areas to obtain the desired rapid cooling. Virtually no data exist as to the effect of the temperatures obtained during commercial hydrocooling on the delay of ripening of peaches shipped in ice refrigerated trucks.

Low temperatures delay the appearance of decay but do not control it. Actually, the brown rot organism (Monilinia fructicola) will grow at 40° F., a temperature considerably lower than is customarily found after hydrocooling or during transit. Since the possibility exists of infection by this and other organisms during transit, chlorine has been added to the hydrocoolers in an attempt to reduce postharvest decay. Other workers have shown that reduction of decay by this chemical at the concentration used in commercial hydrocooling water, was inconsistent or was relatively low.[1] [2] Previous laboratory tests have been conducted with a considerable number of chemicals applied as postharvest treatments for the reduction of brown and rhizopus rots. One of them, Dowicide A (97 percent sodium 0-phenylphenoxide) has shown promise of effectively reducing both of these decays.[3] However, only limited data with this compound in hydrocooling water have been obtained, and it has not been tested under shipping conditions.

Tests were therefore designed to measure (a) the effect of temperature on ripening and bruising of peaches shipped at different maturities, and (b) the reduction of decay by chlorine or Dowicide A when used in the hydrocooling water. In order to evaluate further the effectiveness of rapid cooling paired tests of fruit loaded warm and fruit hydrocooled before loading were planned. However, because of the lack of nonhydrocooled shipments destined for the same receiving point as the hydrocooled, only one nonhydrocooled load was obtained. In conjunction with the shipping tests, information was obtained on (a) reduction in fruit temperatures as a result of commercial hydrocooling; (b) the effect of hydrocooling on basket weight; (c) cooling rate of retail cartons of peaches; and (d) the effect of hydrocooling on the firmness of peaches.

Initial tests were conducted in the area of Chambersburg, Pa., in 1955 and more extensive tests in the Spartanburg, S. C., area in 1956. Since the work in 1955 and 1956 differed in several aspects, each year's tests are presented as a separate part in this report.

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[1] Cardinell, H. A., and Barr, C. Guinn. Packinghouse treatments of Michigan peaches. Mich. Agr. Expt. Sta. Quart. Bul. 32: 70-93. 1949.

[2] Cardinell, H. A., and Barr, C. Guinn. Post-harvest tests with peaches to reduce spoilage. Mich. Agr. Expt. Sta. Quart. Bul. 35: 39-51. 1952.

[3] Smith, W. L., Jr., Haller, M. H., and McClure, T. T., Post-harvest treatments for reduction of brown and rhizopus rots of peaches. Phytopath. 46: 261-264. 1956.

PART I

TESTS OF PENNSYLVANIA PEACHES, 1955

Summary

Peaches classed as ripe (average firmness 6 to 9 pounds) developed commercially important bruises particularly when shipped medium to long distances. Firm ripe and hard peaches (average 11 to 13 and 13 to 15 pounds) were shipped for both medium and long distances with no appreciable amount of serious bruising.

There was some indication that chlorine and Dowicide A added to ice water may reduce peach brown rot when the fruit is shipped under commercial conditions. However, in several loads, a rather excessive amount of brown rot developed on peaches hydrocooled in water containing chlorine. Neither of the fungicides consistently reduced rhizopus rot.

Ice and mechanical flood-type hydrocoolers reduced the temperature of peaches in a short time with approximately equal effectiveness. Fruit temperatures ranging from 68° to 84° F. were lowered approximately 24° during hydrocooling.

Methods Used in Shipping Tests

Preparation of test shipments.--Peaches were sorted as they came from the brusher on the packing line into three maturity classes: "ripe," "firm ripe," and "hard," based on different degrees of blush and development of ground color of the fruit. Firmness was determined on each of the pared cheeks of 25 peaches in each maturity class with a Magness-Taylor pressure tester, using a 5/16-inch plunger. The remaining fruit of each class was then packed into separate 3/4-bushel baskets.

The following treatments were used on peaches of the 3 maturity classes.

1. Hydrocooled in a 55-gallon drum of ice water.
2. Hydrocooled in a 55-gallon drum of ice water containing approximately 0.1 percent Dowicide A.
3. Hydrocooled in a commercial flood-type hydrocooler unit with ice water containing approximately 100 p.p.m. (parts per million) chlorine.

In the drum cooling, pads and lids were left on the baskets; in the commercial hydrocooling, the baskets were unlidded.

Commercially packed peaches, hydrocooled in the commercial unit with ice water containing 100 p.p.m. chlorine, were also included in 4 of the 5 tests.

Test shipments.--After treatment, the test baskets were placed in commercial truckloads of peaches. Recording thermometers were placed in some of the test baskets, and additional thermometers were placed on the inside and outside of the trucks to obtain air temperatures in transit. All test shipments originated in the vicinity of Chambersburg, Pa., and terminated in New York City or Chicago, where they were inspected by personnel of the Market Pathology laboratories of the U. S. Department of Agriculture. Four of the shipments were closed ice refrigerated truck trailers. The fifth was an open uncovered trailer.

Destination inspection. --Fruit temperature, firmness, bruising, and decay were determined upon arrival at destination. Peaches were then held at 70° F. in New York City and at 72° in Chicago, and records were taken at intervals on development of decay and fruit ripening.

Results of Shipping Tests

Fruit temperatures. --The temperature of the different lots of peaches before commercial hydrocooling (ice water plus chlorine) ranged from 73° to 83° F. and after hydrocooling from 45° to 55° (table 1). The peaches hydrocooled in a 55-gallon drum (ice water and ice water + Dowicide A) generally cooled somewhat less than those in the commercial hydrocooler.

As would be expected the hydrocooled fruit warmed up rather rapidly in the open truck (table 3, test 1). In 3 of the 4 refrigerated trucks, the fruit temperature changed very little during the transit period. In the fourth, the temperature dropped about 10 degrees during the 68 hours the fruit was in the truck.

Ripening. --The average firmness of the ripe fruit was 6 to 9 pounds; of the firm ripe, 11 to 13 pounds; and of the hard fruit, 13 to 15 pounds (table 2). The length of time and average temperature during transit (table 3) did not appreciably affect the rate of ripening during the holding periods. During holding periods the ripe fruit became soft ripe in 2 to 3 days, the firm ripe in 4 to 5 days, and the hard in 5 to 7 days. All the fruit classed as ripe or firm ripe at shipping point was reported to ripen satisfactorily. Peaches classed as hard also ripened, but in at least one case were reported to lack good skin color and to be somewhat shriveled.

Bruising. --The most mature peaches (average firmness of 6 to 9 pounds) developed the highest percentage of bruising during transit (table 2). A considerable reduction in percentage and severity of bruising was obtained by shipping firm ripe (average firmness of 11 to 13 pounds) instead of ripe fruit. In these shipments the highest percentage of bruising in the firm ripe class was classified as slight, and therefore possibly of no commercial importance. Almost no bruising of any type developed on fruit classed as hard (average firmness of 13 to 15 pounds) in any of the shipments. In general, the longer the transit period, the greater the severity and the percentage of bruises. The lesser amount of bruising in the open truck (test 1) than in the refrigerated trucks probably is more closely related to the short time in transit than to the temperatures.

Four of the five shipping tests included baskets of the commercially packed peaches, which were a mixture of the three maturity classes described. Bruises on the fruit in these baskets were approximately the same or somewhat higher than on peaches in the firm ripe class. They indicate what may be expected when immature and mature fruit are shipped in the same basket.

Decay. --There was no decay in the test shipments on arrival at destination. In all except test 1, a considerable amount of brown rot developed before the majority of the peaches in any of the 3 maturity classes had become soft ripe. Since the firm ripe peaches constituted the most favorable class, as to quality and freedom from bruising, only details of decay in this class are given (table 4).

Decay records were taken when a majority of the fruit was approximately soft ripe. In test 2, brown rot was markedly reduced by chlorine, and eliminated by Dowicide A. In tests 4 and 5 an excessive amount of brown rot developed on peaches treated with chlorine. Such large amounts of decay would make this fungicide of questionable value for the reduction of brown rot. Development of rhizopus rot in the test shipments was erratic and no accurate evaluation of reduction of this decay could be made.

Hydrocooling Tests

In addition to the shipping tests, records were obtained on the operation of two types of hydrocoolers with peaches packed in 3/4-bushel baskets, and on the hydrocooling of fruit packed in retail cartons placed in wirebound boxes.

Temperatures of peaches located approximately at the middle of the vertical center line in the basket were taken before and after hydrocooling.

A one-unit commercial hydrocooler of the ice-refrigerated flood type and 2-1/2-inch Elberta peaches packed in 3/4-bushel baskets were used in the tests. Eight tests were conducted and the peach temperatures obtained are the average of 15 observations (table 5). Peach temperatures before hydrocooling ranged from 70° to 77° F. Water temperature averaged about 33° to 34°; it changed only slightly during the hydrocooling period. The fruit cooled 21 to 24 degrees in 14 minutes of hydrocooling and 24 to 30 degrees in 17 minutes.

In addition to the temperature data, ten 3/4-bushel baskets of peaches were weighed before hydrocooling and again approximately 5 minutes after hydrocooling. The latter weighing would approximate the time that usually elapses before the baskets are placed in a truck. Before hydrocooling, each basket weighed approximately 41 pounds and at loading weighed 42 pounds. For a trailer carrying 600 baskets of fruit, the gain of one pound per basket, as a result of water accumulation during hydrocooling, would mean an increase of 600 pounds for the load.

Tests were also conducted on the effectiveness of a 2-unit mechanically refrigerated hydrocooler, located at Orefield, Pa., in removing field heat from peaches packed in 3/4-bushel baskets. Refrigeration was supplied by two 80-ton, 7 x 7 ammonia compressors, each powered by a 50-horsepower motor. The compressors were located about 110 feet from the hydrocooler and were part of the regular cold storage refrigeration equipment. Approximately 5,000 feet of 3/4-inch coil was mounted in a specially built tank on top of the hydrocooler to cool the water. The coils were never completely submerged in the water, and a slight amount of icing was observed on the exposed areas. Water temperature in the cooler averaged 33° to 35° F. (table 6).

With fruit temperatures at about 80° F., hydrocooling for 17 to 18 minutes reduced fruit temperature to approximately 52°, whereas hydrocooling for 11 minutes reduced fruit temperature to about 58° (table 6). When the initial fruit temperature was considerably lower (about 65°), hydrocooling 17 minutes reduced the temperature to approximately 45°.

In the test with retail cartons placed in wirebound boxes, each carton contained 8 peaches approximately 2-1/2 inches in size. The cartons were placed on end in the wirebound boxes in 2 rows of 8 each. Temperature of 2 peaches at the top and 2 at the bottom of the cartons were taken before and after hydrocooling. One wirebound box had the lid open and the other had the lid closed when they passed through the hydrocooler. Approximately the same drop in peach temperature was obtained whether the box was open or closed (table 7). However, the peaches in the top layers cooled considerably more than those in the bottom layers.

PART II

TESTS OF SOUTH CAROLINA PEACHES, 1956

Summary

Sixteen truckloads of peaches were shipped from South Carolina in 1956 to determine effect of maturity, hydrocooling and shipping temperature, and fungicidal treatment on bruising and decay of fruit.

Fifteen of the loads consisted of hydrocooled peaches. The other load consisted of nonhydrocooled fruit. All of the fruit was packed in bushel or 3/4-bushel baskets.

Two maturity classes--"firm ripe" and "hard" peaches were used in each test. The fruit was hydrocooled in plain ice water, or in ice water containing either chlorine or Dowicide A. Test lots of the nonhydrocooled fruit had the same treatments in water of room temperature.

Hydrocooling lowered fruit temperatures below 55° F. in about half of the tests. Transit refrigeration was found to be sufficient in most instances to maintain the temperatures of the hydrocooled fruit.

Ripening was faster and bruising was more severe in the firm ripe fruit. Hydrocooling and transit temperatures were not sufficiently low to delay ripening or prevent severe bruising of fruit at this stage of maturity. Peaches in the nonhydrocooled load ripened faster and had more bruises than the hydrocooled. The increase in bruising was important only with the firm ripe peaches.

Brown rot was somewhat greater in the hard fruit than in the firm ripe.

Dowicide A reduced or eliminated brown rot during transit and holding periods in all test lots. Chlorine treatment reduced rot only partially.

A supplemental test on the effect of hydrocooling on the firmness of peaches showed relatively no change in firmness of commercial peaches.

Methods Used in Shipping Tests

Preparation of test shipments. --Two maturities of peaches were selected after they had passed through brushers in commercial packing sheds. They were classed as follows: (a) "firm ripe"--fruit with nearly complete development of yellow ground color and red blush; and (b) "hard"--fruit with green to greenish-yellow ground color and only slight development of red blush. Firmness was determined on each of the pared cheeks of 25 peaches in each maturity class for each shipment with a Magness-Taylor pressure tester, using a 5/16-inch plunger, before the fruit was hydrocooled.

Each maturity class was packed separately in bushel or 3/4-bushel baskets. The bulge after lidding closely approximated the bulge of commercially packed baskets. Three baskets of each maturity class were prepared for each test shipment.

One unlidded basket of peaches in each maturity class was cooled in a commercial flow-type hydrocooler with the ice water containing approximately 125 p.p.m. chlorine. The other two treatments were made in a 50-gallon metal drum. For the plain ice water

(check) treatment, crushed and block ice was added to the water until the water temperature reached approximately 32° F. One basket of each maturity, lidded without pads, was placed upright in the drum. For the Dowicide A treatment, a sufficient quantity of the flakes was added to bring the concentration of that chemical in the previously used ice water to 0.1 percent. Additional ice was added whenever necessary to maintain correct water temperature. Actual concentration of the fungicide and the pH of the water were not measured. The baskets remained in the drum until fruit temperatures approximated that of fruit from the commercial hydrocooler as measured by thermocouples.

The peaches for the nonhydrocooled test were submerged in a barrel of water, or of water containing a fungicide, long enough to insure complete wetting of the fruit. In both instances the water temperature was 70° F. In addition, a basket of dry peaches served to determine the effect of wetting on decay and bruising of the fruit.

Test shipments.--After treatment, the test baskets were placed at the top doorway position in the last two stacks of commercial truckloads of peaches shipped in ice-refrigerated, insulated semitrailers. All trucks originated in the vicinity of Spartanburg, S. C., and were shipped to eastern and midwestern markets (table 8). Recording thermometers were placed in baskets of commercial fruit before hydrocooling, and the baskets were placed at the bottom bunker, middle-half, and top doorway positions in the centerline of each load. Drivers were requested to maintain a log of each trip to include stops en route, amount of ice added, and outside air temperatures whenever possible.

Destination inspection.--Fruit temperatures and general appearance of the loads were obtained whenever possible. Fifty fruit from each maturity class and treatment were examined as soon as possible for the bruising, ripening, and decay that occurred during transit. The remaining fruit was held at 70° to 75° F., and samples were examined for bruising, ripening, and decay at intervals until the fruit was soft ripe.

Condition of trailers.--All trailers were inspected before loading and showed considerable variation in their condition. Some were in excellent condition while others were quite poor. No reliable information could be obtained as to the amount or condition of the insulation in the trailers, although it was estimated that it averaged about 2 inches in thickness.

Results of Shipping Tests

Fruit temperatures.--Temperatures of the test fruit ranged between 78° and 90° F. before commercial hydrocooling (table 9). During the 10 to 24 minutes necessary for the fruit to pass through the cooler, the temperatures were usually lowered 20° to 30°. Fruit hydrocooled in the metal drum, with or without the fungicide, was cooled in approximately 30 minutes to approximately the same temperature as the commercially treated fruit. In most tests fruit temperatures in the test baskets placed in the top doorway position either did not change appreciably during transit or were slightly lowered. In 3 instances, fruit temperatures increased 6 or 7 degrees during transit.

In the commercial loads, the average temperatures in the 3 locations of 11 different trucks showed little difference in cooling rate or temperatures in the various positions (fig. 1). Cooling was not as uniform throughout the truck in the one load of nonhydrocooled peaches (fig. 2). The average temperature of this load was reduced from approximately 84° F. to 63° during the 36-hour period.

Ripening.--Peaches ripened somewhat during transit in almost all tests (tables 10 and 11). Generally, the least ripening occurred with transit temperatures averaging less than 55° F., and the most in those averaging 60° or above. At the higher transit temperatures the longer transit periods also contributed to the rate of softening. The firm ripe peaches generally ripened more than the hard fruit, except when transit temperatures averaged above 60°. More ripening occurred in the nonhydrocooled load (2B) than in its companion hydrocooled load (2A).

During the holding period at 70° to 75° F., firm ripe fruit with transit temperatures above 55° were generally soft ripe in 1 to 2 days. Those with transit temperatures averaging below 55° were soft ripe in 2 to 3 days. The effect of temperature on ripening of the harder fruit was somewhat inconsistent. The two fungicides had little or no effect on ripening.

Bruising.--Bruising during transit was influenced by the maturity at shipping point and the amount of ripening during transit (tables 10 and 11). Fruit classed as firm ripe bruised more than the hard fruit. The most mature peaches (tests 8 and 14) developed the highest percentage of severe bruising. When peaches ripened during transit to a firmness of approximately 9 pounds, usually a high percentage of severe bruising developed. Only at the higher transit temperatures, when an appreciable amount of ripening occurred, was the amount or the severity of the bruises affected by the duration of the transit period. More bruising occurred in the nonhydrocooled (2B) than in the companion hydrocooled load (2A).

Decay.--During transit, brown rot developed in 2 tests with the hydrocooled firm ripe peaches and in 4 tests with the hard fruit (tables 10 and 11). Dowicide A eliminated or reduced transit decay, but chlorine gave erratic or no decay reduction.

During the holding period, decay again developed in a larger number of tests with the hard fruit than with the firm ripe fruit. The percentages of decay within individual tests were also higher in the hard than in the firm ripe fruit. When decay was serious in the check fruit (hydrocooled in ice water only) it was substantially reduced or eliminated by Dowicide A, but somewhat erratically reduced by chlorine. When lesser amounts of decay developed, Dowicide A eliminated it in most cases, but reduction by chlorine was again inconsistent. In certain test lots, Dowicide A caused a slight, insignificant mottling on the surface of the fruit.

Slightly more decay developed in the nonhydrocooled peaches than in the companion hydrocooled fruit. Wetting the fruit did not seem to influence the development of decay.

Development of rhizopus rot throughout the tests (tables 10 and 11) was inconsistent and no proper evaluation could be made of maturity and fungicide protection in relation to decay.

Effect of Hydrocooling on Firmness

In conjunction with the shipping tests, the effect of hydrocooling on the firmness of peaches was studied. Eight tests were made in the Spartanburg area with 5 varieties of peaches from several different packing sheds. Three maturity classes of peaches were selected: (a) "ripe"--peaches with full development of yellow ground color and red blush, (b) "firm ripe"--nearly full development of yellow ground color and red blush and (c) "hard"--ground color mostly green or yellow green, and only slight development of red blush. The ripe peaches consisted of fruit graded as too ripe for commercial shipment. Firmness was determined on samples of 25 peaches before hydrocooling, immediately after hydrocooling, and after the fruit had warmed to the original fruit temperature. In all cases the hydrocooling water was approximately 32° F., and the peaches passed through the cooler in 15 to 20 minutes.

In most cases, the ripe peaches increased in firmness during the hydrocooling process with increases of as much as one pound pressure. The average of the 8 tests showed an increase of only 0.5 pounds (table 12). However, when these peaches had warmed to their original temperature, the average firmness was considerably below the original test. Hydrocooling usually did not increase the firmness of the firm ripe and hard fruit, or the increase was so slight as to be inconclusive. In most cases when the fruit had warmed up, the average firmness was below that of the original test. These data demonstrate that hydrocooling does not affect the firmness of commercially acceptable fruit.

Observations on Commercial Hydrocooling Operations

The operation of a number of hydrocoolers in the area were observed during the period of the shipping tests. The temperature of the hydrocooled fruit varied from 48° to 64° F. and averaged about 53°. Higher temperatures were found in larger fruit of 2-1/4- and 2-1/2-inch size. In normal operation lots of larger fruit were handled with no attempt by the operator to slow down the conveyor to compensate for the lower cooling rate of the larger peaches. Icing practices varied, resulting in water temperatures as high as 45° in one case. In most instances the operator did not know the actual temperature of the fruit either before or after hydrocooling. Newer installations were equipped with ice storage facilities and more attention was given to minimizing the labor required in handling the ice.

Discussion

These tests show the relationship of transit temperatures to ripening and bruising. Temperatures above 55° resulted in more ripening and more bruising, particularly of firm ripe fruit, than lower temperatures. Therefore, these data indicate that transit temperatures control to some extent the stage of maturity at which peaches may be shipped in the standard peach basket. It is apparent that under the conditions of these tests the transit temperatures were not low enough to arrest appreciably the ripening of peaches classed as firm ripe at shipping point, so that an excessive amount of transit bruising occurred in most cases.

While the peach industry's desire is to ship more mature fruit, these results indicate that mature fruit cannot be shipped successfully in the present containers, even though hydrocooled, unless transit and hydrocooling temperatures are lowered sufficiently to reduce ripening to a greater degree. This emphasizes the need for a container that will protect the fruit better under the present handling methods.

The fungicide tests showed the effectiveness of Dowicide A in reducing or eliminating the development of brown rot and its superiority over chlorine. However, before Dowicide A can be recommended for commercial use in hydrocooling water for peaches, there is need for (1) more information on its stability in the hydrocooling water for extended periods, (2) a simple method of determining its concentration in the water, and (3) a determination by the Food and Drug Administration of an allowable tolerance for residue on peaches. Even though these 3 conditions can be met and effective control of brown rot in transit accomplished, this should not be construed as the signal for any reduction in the measures used for orchard control of the disease.

These data show more decay in hard fruit than in firm ripe fruit, probably because of the longer time required for the hard peaches to become soft ripe. Since riper fruit are recognized to have a better appearance and higher quality, this possible reduction of decay may be an additional advantage of shipping firm ripe rather than hard fruit.

While it is often assumed that rapid lowering of peach temperatures during hydrocooling increases their firmness, and hence their resistance to bruising, the supplementary test does not support this belief.

Data from the single nonhydrocooled shipment showed that the firm ripe peaches ripened considerably during transit and bruised excessively. Greater losses of peaches of this maturity class may therefore be expected in nonhydrocooled than in hydrocooled loads. On the other hand the hard fruit, which ripened more in the nonhydrocooled than in the hydrocooled load, did not bruise excessively. These data therefore indicate that though firm ripe fruit may develop excessive bruises unless hydrocooled, hard fruit may be shipped satisfactorily by truck when either hydrocooled or nonhydrocooled if it is adequately refrigerated in transit.

These studies show a wide range in temperatures of peaches after hydrocooling, reflecting the diversity of supervision given by the different operators. In newer installations greater attention is given to the installation of the hydrocoolers and to better

arrangement of the icing facilities. Building of local ice storage facilities provides protection against shutdowns in packing operations. Constant supervision should be given to the icing in order to maintain a desirable water temperature of from 32° to 34° F. For proper cooling, a machine of sufficient size should be installed to handle the output of the packing line without crowding or running the hydrocooler conveyor too fast, which results in insufficient cooling.

The truck-trailer equipment used in the tests was generally able to maintain the temperature of the hydrocooled peaches in transit, though many were on the borderline. While the condition of the equipment is important, the maintenance of proper transit temperatures is largely dependent on the performance of the truck operator. The icing records obtained indicate that some operators are quite lax in the attention given to their loads.

APPENDIX

Table 1.--Relationship of cooling method to amount of cooling of peaches--Pennsylvania, 1955

Test shipment and peach maturity	Type of cooling and treatment[1]	Average fruit temperatures		Average cooling obtained
		Before hydrocooling	After hydrocooling	
		°F.	°F.	°F.
Test 1:				
Ripe.....	Ice water	69	52	17
	Ice water + Dowicide A	70	54	16
	Ice water + chlorine	73	53	20
Firm ripe.....	Ice water	69	54	15
	Ice water + Dowicide A	71	54	17
	Ice water + chlorine	73	51	22
Hard.....	Ice water	70	54	16
	Ice water + chlorine	73	51	22
Test 2:				
Ripe.....	Ice water	82	53	29
	Ice water + Dowicide A	81	60	21
	Ice water + chlorine	81	55	26
Firm ripe.....	Ice water	82	61	21
	Ice water + Dowicide A	82	58	24
	Ice water + chlorine	82	52	30
Hard.....	Ice water	82	53	29
	Ice water + Dowicide A	82	55	27
	Ice water + chlorine	82	45	37
Test 3:				
Ripe.....	Ice water + chlorine	80	54	26
Firm ripe.....	Ice water + chlorine	80	51	29
Hard.....	Ice water + chlorine	80	53	27
Test 4:				
Ripe.....	Ice water + chlorine	83	54	29
Firm ripe.....	Ice water + chlorine	82	55	27
Hard.....	Ice water + chlorine	81	54	27
Test 5:				
Ripe.....	Ice water + chlorine	74	53	21
Firm ripe.....	Ice water + chlorine	74	54	20
Hard.....	Ice water + chlorine	74	52	22

[1] Ice water and ice water + Dowicide A treatments applied by submerging lidded 3/4-bushel baskets in drums of the treating solution. Ice water + chlorine treatment applied by passing unlidded 3/4-bushel baskets through flood-type ice-refrigerated hydrocooler.

Table 2.--Relationship of peach maturity and length of transit period to bruising of hydrocooled peaches--Pennsylvania, 1955[1]

Test shipment[2] and peach maturity	Firmness at shipping point	Time in transit	Peaches	Bruising at destination			
				Slight	Moderate	Severe	Total
Test 1:	*Pounds pressure*	*Hours*	*Number*	*Percent*	*Percent*	*Percent*	*Percent*
Ripe.....	6	8	258	20	6	2	28
Firm ripe.....	12	8	302	3	1	0	4
Hard.....	13	8	242	1	1	0	2
Test 2:							
Ripe.....	6	16	278	30	8	2	40
Firm ripe.....	11	16	291	7	1	0	8
Hard.....	15	16	330	4	0	0	4
Comm. pack....	--	16	137	6	2	2	10
Test 3:							
Ripe.....	8	20	119	30	7	0	37
Firm ripe.....	13	20	101	17	2	0	19
Hard.....	15	20	131	1	0	0	1
Comm. pack....	--	20	121	12	2	2	16
Test 4:							
Ripe.....	9	32	82	7	21	21	49
Firm ripe.....	12	32	86	11	6	5	22
Hard.....	14	32	85	4	0	0	4
Comm. pack....	--	32	73	14	11	12	37
Test 5:[3]							
Ripe.....	7	68	93	--	--	--	42
Firm ripe.....	13	68	88	--	--	--	9
Hard.....	15	68	101	--	--	--	4
Comm. pack....	--	68	120	--	--	--	12

[1] All peaches in 3/4-bushel baskets.
[2] Tests 1, 2, and 3, to New York; tests 4 and 5 to Chicago.
[3] Records taken only on total amount of bruising.

Table 3.--Peach and air temperatures during transit in truck shipping tests--Pennsylvania, 1955[1]

Test No., shipping point, and destination	Transit dates	Location of thermometer	Time intervals (hours)																
			Start	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68
			°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1	8/10	Fruit	48	62	65														
Waynesboro, Pa. to		Fruit	50	67	70														
New York, N. Y.[2]		Outside air	78	91	78														
2	8/16	Fruit	45	52	51	50	50												
New Franklin, Pa. to	to	Fruit	48	53	53	52	51												
New York, N. Y.	8/17	Inside air	52	53	49	50	54												
		Outside air	86	91	78	76	95												
3	8/17	Fruit	51	51	51	50	50	50											
New Franklin, Pa. to	to	Inside air	51	51	51	51	51	51											
New York, N. Y.	8/18	Outside air	72	75	72	74	78	81											
4	8/16	Fruit	51	51	51	51	52	52	52	52	52								
New Franklin, Pa. to	to	Fruit	53	53	52	53	53	53	52	52	52								
Chicago, Ill.	8/18	Outside air	83	75	80	74	85	87	83	75	79								
5	8/30	Fruit	52	48	47	46	46	46	47	47	47	46	45	44	44	43	43	43	42	42
New Franklin, Pa. to	to	Inside air	54	58	50	50	57	52	51	51	50	47	47	47	49	52	47	44	44	43
Chicago, Ill.	9/2	Outside air	83	86	93	73	67	65	63	73	72	70	67	63	61	70	74	70	66	63

[1] All peach containers 3/4-bushel baskets.
[2] Test 1 fruit in open truck, all others in refrigerated trucks.

Table 4.--Relationship of fungicidal treatment to development of decay of peaches shipped at firm ripe or mixture of maturities--Pennsylvania, 1955

Test No. and fruit maturity at shipping point	Fungicidal treatment[1]	Peaches	Decay[2]		
			Brown rot	Rhizopus rot	Total
		Number	*Percent*	*Percent*	*Percent*
Test 1:					
Firm ripe.....	None	79	1	3	4
Firm ripe.....	Dowicide A 0.1%	80	1	14	15
Firm ripe.....	Chlorine 100 p.p.m.	68	0	0	0
Test 2:					
Firm ripe.....	None	71	55	0	55
Firm ripe.....	Dowicide A 0.1%	56	0	5	5
Firm ripe.....	Chlorine 100 p.p.m.	67	22	0	22
Mixed[3].....	Chlorine 100 p.p.m.	91	26	0	26
Test 3:					
Firm ripe.....	Chlorine 100 p.p.m.	93	16	0	16
Mixed[3].....	Chlorine 100 p.p.m.	105	11	0	11
Test 4:					
Firm ripe.....	Chlorine 100 p.p.m.	58	52	4	56
Mixed[3].....	Chlorine 100 p.p.m.	110	47	1	48
Test 5:					
Firm ripe.....	Chlorine 100 p.p.m.	66	18	8	26
Mixed[3].....	Chlorine 100 p.p.m.	53	51	17	68

[1] None (ice water) and Dowicide A (in ice water) treatments applied by submerging lidded 3/4-bushel baskets in drums of the treating solution. Chlorine treatment applied by passing 3/4-bushel baskets through a flood-type, ice-refrigerated hydrocooler.
[2] Decay readings were made after holding at 70° or 72° F. when the firmness of peaches was 1.5 to 2.0 pounds.
[3] Commercial pack containing several maturities.

Table 5.--Relationship of initial fruit temperature and length of cooling to the amount of cooling obtained with a single-unit commercial ice-refrigerated, flood-type hydrocooler--Pennsylvania, 1955[1]

Sample No.	Average water temperature[2]	Average fruit temperature[2]		Time in cooler	Average cooling obtained
		Before hydrocooling	After hydrocooling		
	°F.	°F.	°F.	*Min.*	°F.
1.....	34	70	50	14	20
2.....	34	71	49	14	22
3.....	33	71	47	14	24
4.....	33	70	47	14	23
5.....	33	73	48	17	25
6.....	33	74	47	17	27
7.....	33	77	48	17	29
8.....	33	77	47	17	30

[1] All tests with 2-1/2-inch Elberta peaches in 3/4-bushel baskets.
[2] Each temperature is average of 15 readings.

Table 6.--Relationship of initial fruit temperature and length of cooling to the amount of cooling obtained with a 2-unit commercial mechanically refrigerated flood-type hydrocooler--Pennsylvania, 1955[1]

Test No.[2]	Average water temperature	Average fruit temperature		Time in cooler	Average cooling obtained
		Before hydrocooling	After hydrocooling		
	°F.	°F.	°F	Min.	°F.
1.....	33	78	55	11	23
2.....	34	81	61	11	20
3.....	34	84	52	18	32
4.....	34	80	53	17	27
5.....	34	63	45	17	18
6.....	34	65	45	17	20
7.....	35	67	49	17	18

[1] All tests with 2-inch and up Brackett peaches brushed and packed in 3/4-bushel baskets.
[2] Each test is an average of 5 observations.

Table 7.--Relationship of position of retail cartons in wirebound boxes to amount of cooling in a mechanically refrigerated flood-type hydrocooler--Pennsylvania, 1955[1]

Test package	Position in box	Average fruit temperature		Time in cooler	Average cooling obtained
		Before hydrocooling	After hydrocooling		
		°F.	°F.	Min.	°F.
A--open					
	Bottom	80	64	17	16
	Top	77	49	17	28
	Bottom	79	59	17	20
	Top	80	54	17	26
B--closed					
	Bottom	80	62	17	18
	Top	79	53	17	26
	Bottom	80	60	17	20
	Top	79	53	17	26

[1] Tests were made with 2-1/2-inch brushed Brackett peaches.

Table 8.--Variety, source, destination, and hours in transit of peaches used in shipping tests--South Carolina, 1956

Test No.	Variety	Loading point	Destination	Hours in transit
1.....	Burnett Elberta	Woodruff, S. C.	New York, N. Y.	60
2A.....	Goldeneast	Greer, S. C.	" "	36
2B[1]				
3.....	Halehaven	Woodruff, S. C.	" "	36
4.....	Halehaven	" "	Chicago, Ill.	36
5.....	Halehaven	" "	New York, N. Y.	60
6.....	Halehaven	Cowpens, S. C.	Chicago, Ill.	36
7.....	Burnett Elberta	Inman, S. C.	Altoona, Pa.	36
8.....	Sullivan Elberta	Greer, S. C.	New York, N. Y.	36
9.....	Sullivan Elberta	York, S. C.	Washington, D. C.	15
10.....	Elberta	Inman, S. C.	New York, N. Y.	72
11.....	Elberta	Gramling, S. C.	Chicago, Ill.	48
12.....	Elberta	Cherokee Sp., S. C.	" "	36
13.....	Elberta	Cherokee Sp., S. C.	New York, N. Y.	36
14.....	Elberta	Woodruff, S. C.	" "	60
15.....	Elberta	Inman, S. C. Holly Springs	" "	36

[1] Test No. 2B nonhydrocooled.

Table 9.--Temperature of peaches before and after hydrocooling and during transit (at top doorway position)--South Carolina, 1956

Test No.	Time in hydrocooler	Fruit temperatures							
		Before hydrocooling	After hydrocooling	During transit (hours)					
				12	24	36	48	60	72
	Minutes	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1.....	24	79	51	51	51	53	52	51	--
2A.....	12-3/4	80	54	53	53	53	--	--	--
2B[1].....	--	--	[1] 84	79	74	66	--	--	--
3.....	17	81	56	57	55	52	--	--	--
4.....	17	81	51	54	52	49	--	--	--
5.....	13	82	60	61	60	62	61	66	--
6.....	10	81	61	58	56	53	--	--	--
7.....	13	79	57	55	54	54	--	--	--
8.....	13	81	55	54	51	62	--	--	--
9.....	14-1/2	84	60	55	--	--	--	--	--
10.....	12	86	64	62	60	56	54	50	49
11.....	17	78	50	47	48	47	45	--	--
12.....	15	78	51	50	48	50	--	--	--
13.....	16	80	48	50	48	47	--	--	--
14.....	14	78	55	57	59	61	62	62	--
15.....	11	90	62	62	63	62	--	--	--

[1] Test 2B nonhydrocooled.

Table 10.--Relationship of temperature and length of transit to ripening, bruising, and decay of firm ripe peaches--South Carolina, 1956

Test No.	Temperature		Transit period	Firmness[1]		Change during transit	Time to ripen at 70° to 75°	Transit bruising			Decay											
											Brown rot						Rhizopus rot					
											On arrival			When ripe[2]			On arrival			When ripe[2]		
	After hydro-cooling	Average during transit		At shipping point	On arrival			Slight	Moderate	Severe	H_2O ([3])	Cl.[3]	Dow. A[3]	H_2O ([3])	Cl.[3]	Dow. A[3]	H_2O ([3])	Cl.[3]	Dow. A[3]	H_2O ([3])	Cl.[3]	Dow. A[3]
	°F.	°F.	Hours	Pounds pressure	Pounds pressure	Pounds pressure	Days	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
1....	51	51.5	60	14.4	10.4	-4.0	2	8.1	2.7	0.8	10	2	0	46	30	2	4	4	0	0	4	2
11...	50	47.4	48	11.8	8.4	-3.4	2	8.0	10.0	8.3	0	0	0	0	0	0	0	0	0	0	0	0
12...	51	49.7	36	11.8	8.5	-3.3	2	14.7	9.3	11.0	0	0	0	0	0	0	0	0	0	2	0	0
13...	48	48.2	36	12.4	13.2	+0.8	3	7.0	8.0	7.8	0	0	0	20	14	0	0	0	0	2	0	0
2A...	54	53.2	36	12.0	6.9	-5.1	2	9.3	6.3	4.0	0	0	0	0	6	0	2	0	0	0	0	0
3....	56	55.0	36	11.1	7.6	-3.5	2	12.3	11.7	10.7	0	0	0	0	0	0	0	0	0	2	2	0
4....	51	51.6	36	11.1	11.2	+0.1	2	13.0	12.7	9.3	0	0	0	2	4	0	0	0	0	2	4	4
6....	61	57.0	36	10.4	8.6	-1.8	1	14.0	6.3	1.3	0	0	0	0	0	0	0	0	0	0	0	0
7....	57	55.0	36	9.7	4.3	-5.4	1	17.7	14.0	16.3	0	0	0	0	4	0	0	0	0	2	10	4
8....	55	53.0	36	9.7	4.2	-5.5	1	14.3	19.0	20.7	0	0	0	0	0	0	0	0	0	0	0	0
9....	60	57.5	15	10.5	10.7	+0.2	2	17.7	11.0	9.3	0	0	0	0	0	2	0	0	0	0	2	0
14...	55	59.3	60	9.2	1.9	-7.3	0	22.7	18.7	23.3	0	0	0	--	--	--	0	0	0	--	--	--
10...	64	56.4	72	11.0	2.8	-8.2	1	10.3	13.0	10.3	0	0	0	0	0	0	0	0	0	0	0	0
5....	60	61.6	60	11.5	2.6	-8.9	1	10.7	13.7	11.3	0	6	0	2	0	0	0	0	0	0	0	0
15...	62	62.2	36	10.9	3.9	-7.0	2	13.3	14.0	9.6	0	0	0	4	0	0	0	0	0	0	0	0
2B[4]..	--	75.7	36	12.0	2.6	-9.4	1-2	18.0	17.0	11.0	2	0	0	6	0	2	2	0	0	8	0	0

[1] As measured by Magness-Taylor fruit pressure tester with 5/16-inch plunger.
[2] When the peaches were soft.
[3] H_2O, Cl, Dow. A indicate water dip, chlorine, and Dowicide A treatments respectively.
[4] Nonhydrocooled load.

Table 11.--Relationship of temperature and length of transit to ripening, bruising and decay of hard peaches--South Carolina, 1956

Test No.	Temperature		Transit period	Firmness[1]			Time to ripen at 70° to 75°	Transit bruising			Decay											
											Brown rot						Rhizopus rot					
											Arrival			When ripe[2]			Arrival			When ripe[2]		
	After hydro-cooling	Average during transit		Shipping point	On arrival	Change during transit		Slight	Moderate	Severe	H_2O ([3])	Cl.[3]	Dow. A[3]	H_2O ([3])	Cl.[3]	Dow. A[3]	H_2O ([3])	Cl.[3]	Dow. A[3]	H_2O ([3])	Cl.[3]	Dow. A[3]
	°F.	°F.	Hours	Pounds pressure	Pounds pressure	Pounds pressure	Days	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
1....	51	51.5	60	16.3	16.6	+0.3	3	4.2	0.4	0.2	4	2	2	68	56	8	2	0	0	2	2	0
11...	50	47.4	48	14.6	13.3	-1.3	2	7.7	1.3	1.3	0	0	0	2	0	0	0	0	0	0	0	0
12...	51	49.7	36	14.8	12.8	-2.0	3	9.3	2.0	2.7	0	0	0	12	2	0	0	0	0	36	2	0
13...	48	48.2	36	15.9	14.2	-1.7	3	5.1	1.6	1.1	0	0	0	16	0	0	0	0	0	0	10	4
2A...	54	53.2	36	15.3	13.9	-1.4	3	6.7	1.3	.7	2	4	0	4	4	2	0	0	0	0	0	0
3....	56	55.0	36	14.5	13.3	-1.2	2	5.0	3.3	.3	0	0	0	2	0	0	0	0	0	0	0	0
4....	51	51.6	36	14.5	14.6	+.1	2	7.0	4.3	2.3	0	0	0	0	0	0	0	0	0	0	0	0
6....	61	57.0	36	12.6	10.5	-2.1	1	5.3	2.3	0	0	0	0	0	2	0	0	0	0	0	0	0
7....	57	55.0	36	13.7	10.9	-2.6	1	7.3	3.0	1.3	0	0	0	4	2	2	0	0	0	2	0	0
8....	55	53.0	36	12.5	7.1	-5.4	2	9.7	14.3	12.9	0	0	0	4	0	0	0	0	0	0	0	0
9....	60	57.5	15	12.8	12.7	-.1	2	12.0	3.0	3.0	0	0	0	0	0	0	0	0	0	0	0	0
14...	55	59.3	60	12.2	3.1	-9.1	2	15.6	12.8	8.4	2	0	0	10	2	0	0	0	0	0	0	0
10...	64	56.4	72	13.8	3.7	-10.1	1	8.0	6.0	4.0	2	2	0	4	4	0	0	0	0	0	0	0
5....	60	61.6	60	14.5	4.4	-10.1	2	4.9	2.5	.7	0	0	0	4	0	0	0	0	0	0	0	0
15...	62	62.2	36	15.2	8.6	-6.6	3	4.2	3.8	1.1	0	0	0	34	10	0	0	0	0	0	0	0
2B[4]..	--	75.7	36	15.3	6.8	-8.5	2-3	12.7	7.3	3.0	8	2	0	6	6	6	0	0	0	0	0	0

[1] As measured by Magness-Taylor fruit pressure tester with 5/16-inch plunger.
[2] When the peaches were soft.
[3] H_2O, Cl, Dow. A indicate water dip, chlorine, and Dowicide A treatments respectively.
[4] Nonhydrocooled load.

Table 12.--Firmness of peaches of different stages of maturity before and after hydrocooling--South Carolina, 1956

Test No.	Variety	Fruit temperature		Average firmness[1]								
				Ripe fruit			Firm ripe fruit			Hard fruit		
		Before hydro-cooling	After hydro-cooling	Before hydro-cooling	After hydro-cooling	When warm	Before hydro-cooling	After hydro-cooling	When warm	Before hydro-cooling	After hydro-cooling	When warm
		°F.	°F.	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
1.....	Triogem	80	50	4.8	5.1	4.8	10.4	11.4	10.1	13.1	13.5	13.9
2.....	Jerseyland	80	55	6.8	7.4	8.4	11.6	11.4	11.8	15.2	13.4	14.2
3.....	Triogem	75	50	8.0	6.6	4.8	11.2	12.7	9.1	16.3	16.2	15.9
4.....	Golden Jubilee	77	51	4.6	5.0	3.6	12.1	10.9	9.5	14.6	14.1	13.9
5.....	Triogem	78	54	4.7	5.8	1.8	10.4	10.6	7.3	12.8	12.7	10.5
6.....	Triogem	77	[2] 43	4.4	5.3	2.0	9.5	10.8	8.1	12.1	11.5	10.0
7.....	Goldeneast	75	53	4.3	5.7	4.0	10.7	10.7	7.1	13.2	12.4	11.9
8.....	Sullivan Elberta	84	55	4.4	5.7	1.9	11.0	9.9	7.3	14.0	12.8	12.0
Average	----------	--	--	5.3	5.8	3.9	11.1	11.1	8.6	13.9	13.3	12.8

[1] As measured by Magness-Taylor fruit pressure tester with 5/16-inch plunger.
[2] Run through hydrocooler twice.

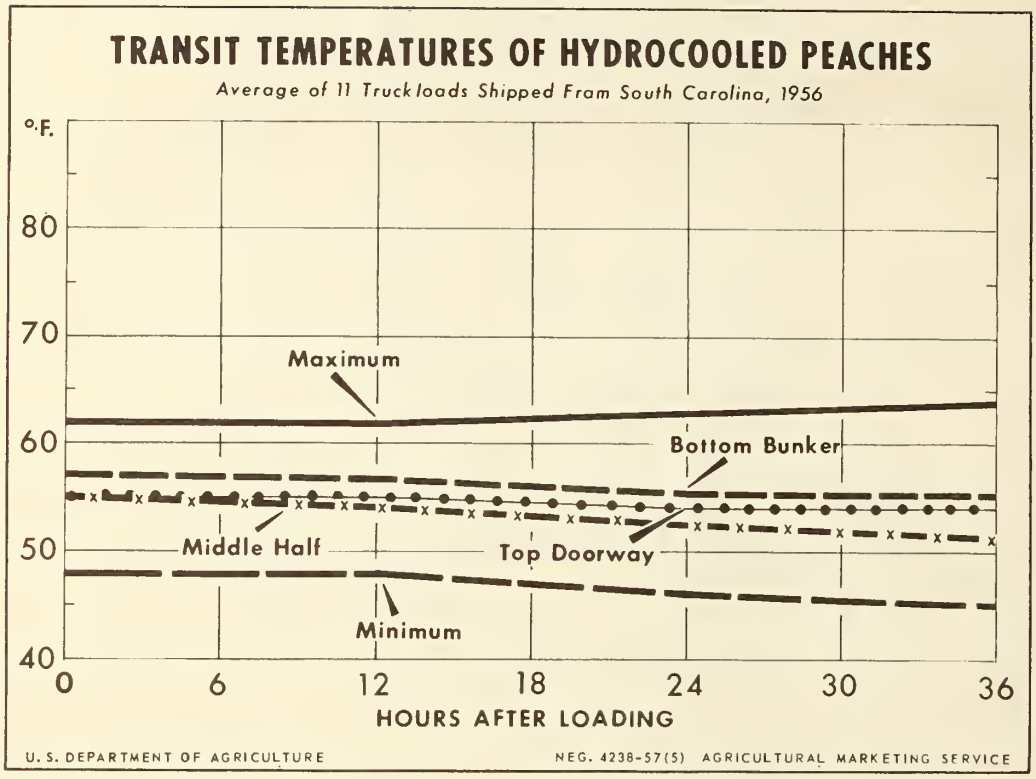

Figure 1

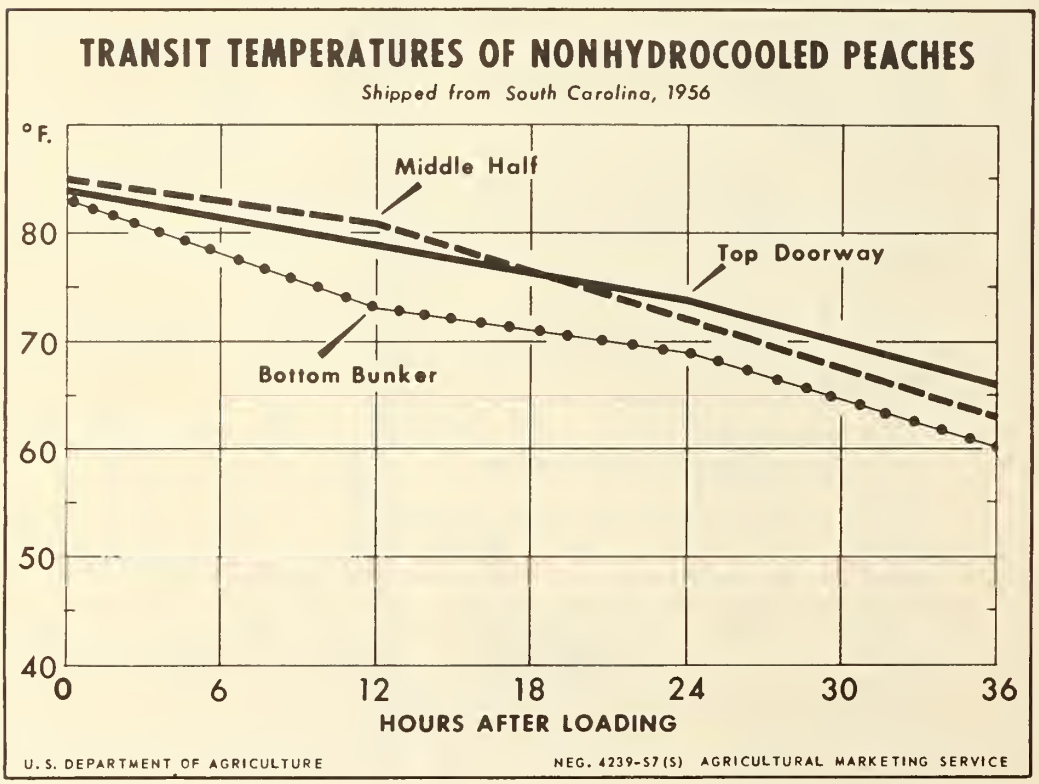

Figure 2